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ABSTRACT

The most recent work of the Computer Applications Laboratory (CAL) is summarized in this report. CAL conducts research in the area in which fundamental learning processes, topical education tasks, and technology intersect, seeks to meet the challenge of societal/educational problems, designs prototype courses using multimedia, computer-controlled devices, develops computer-based learning systems, and carries on graduate training. The first major section of this annual report reviews Office of Naval Research projects on learning strategies, training strategies, and computer system strategies. Part II summarizes Federal and state funded projects dealing with: 1) computer-assisted instruction (CAI) in social work education, 2) parent counseling; 3) instructional models for individualized technical training, 4) Air Force personnel assignment, 5) public service careers, 6) CAI reading programs, 7) needs assessment for mentally retarded children in Florida, and 8) concept acquisition. The third section describes the status of the graduate program, while the final one reviews university sponsored projects in biology, health education, curriculum planning and administration, and physics. (PB)

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# Computer Applications Laboratory

(COMPUTER-ASSISTED INSTRUCTION CENTER)

ANNUAL PROGRESS REPORT

1 January 1972 through 31 December 1972

CENTER FOR EDUCATIONAL TECHNOLOGY

COLLEGE OF EDUCATION

Florida State University

EM 011 391

ED 081214

# COMPUTER APPLICATIONS LABORATORY

# (COMPUTER-ASSISTED INSTRUCTION CENTER)

## ANNUAL PROGRESS REPORT

1 January 1972 through 31 December 1972

**Center for Educational Technology**

**College of Education**

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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**Prepared by:**

Duncan N. Hansen
Robert D. Tennyson
Barbara F. Johnson
Michael J. O'Halloran

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# INTRODUCTION

The Computer-Assisted Instruction (CAI) Center, as a result of university-wide reorganization at Florida State University, has been placed in the Center for Educational Technology, College of Education. Hence, the Center will be known as the Computer Applications Laboratory.

However, for purpose of clarity within this report, the Laboratory will be referred to as the CAI Center. The Center objectives are:

1. To pursue basic research that represents the intersection of fundamental, human learning processes with current and topical educational tasks, while having the use of the most advanced technologically-automated equipment.

2. To pursue the challenge of current societal/educational problems that provide for an interdisciplinary approach that utilizes instructional technology.

3. To participate in the design of prototype course units that best reflect the conceptual aspects of instructional science and the technological aspect of multimedia, computer-controlled devices.

4. To develop advanced computer-based learning systems that provide for incremental advantages in terms of student learning, instructional management, and cost-effectiveness.

5. To continue its current activity relating to teaching and graduate training as a component within the instructional systems group.

The annual report is divided into the following categories: (a) Office of Naval Research, (b) Federal and State Funded Projects, (c) the Current Graduate Program, (d) University Sponsored Projects, and (e) the CAI Center (personnel and equipment). Two appendices are attached. The first appendix contains a list of publications by Center personnel and a list of Center publications. The second appendix is a list of visitors to, and a list of demonstrations provided by the Center.

## OFFICE OF NAVAL RESEARCH

Under the sponsorship of the Office of Naval Research, Department of Defense, the Florida State University Computer-Assisted Instruction (CAI) Center simultaneously conducts research and development in four interrelated areas: learner strategies, training strategies, validation strategies, and computer systems strategies. The validation strategies studies were completed in prior years. The other three strategies will be discussed in the following section.

**Learner Strategies**

Studies of learner strategies within a CAI context are specifically oriented toward assessing those trainee characteristics which influence the learning achievement of trainees. Research on trainee characteristics is in progress in three main areas. These areas examine: (a) the presentation of behavioral objectives to provide learners with information pertaining to selecting strategies, (b) the influence of anxiety and its interrelationships to learner strategies, and (c) the effectiveness of different modes of responding in programmed instruction and CAI.

*Effects of providing organizational information on learner strategies.* One of the perplexing problems within the recent upsurge of interest in behavioral objectives has been the seemingly inconsistent results obtained by researchers. Some studies found positive results in presenting objectives to students, while others did not. A comprehensive review of this area (25 empirical investigations were reviewed in detail) demonstrated this state of findings systematically by analyzing studies according to main effect findings, objective and type of learning interactions, and objective/learner control interactions.

Included in the review were studies performed during the same period of time at the FSU CAI Center. The first study tested the effects of objectives in a graduate computer-managed course. No effects of objectives were found on measures of test item-response latency, study time, or performance on unit tests. A significant decrease in state anxiety was found in the beginning of the course. A second study tested the interaction of instructional sequence by providing half of the students with objectives and an ordered sequence, and the other half with objectives and scrambled sequence. Again, no main or interaction effects were found. In addition, this study found no effect of objectives on state anxiety.

A third study did find main effects of objectives. Using a brief text as the instructional material some subjects received half of 24 objectives for the text while the remaining subjects received no objectives. The subjects with half of the objectives performed significantly better than the control group on items referenced to the objectives and less well on "no objective" items. The conflict in findings with previous research is tentatively explained as the result of students having had prior experience with an objective-referenced instructional model. These studies and the overview of research led the Center into a different line of research on objectives.

Another series of studies therefore investigated the effects of presenting rules with objectives. Here the results were more consistently positive. In one study, using both rules and objectives in a learner-controlled situation, the presentation of rules was found to be more effective than the presentation of objectives. A second study replicated these results and demonstrated that rules also reduced display latency and test-item response latency with increased retention test performance. Further, rules decreased the level of state anxiety during the task. A third study tested the effect of providing prior examples and problems on the learning of rules. The availability of prior examples clearly increased the efficiency (less time taken) of rule problem-solving, although it was not more effective in terms of performance. This series of studies demonstrates that presentation of some forms of prior information, in this case rules and examples in problem-solving instruction, seemingly affects learner strategies to improve performance and efficiency. Current investigation in this area is concerned with the conditions for most effectively presenting rules, particularly as to the position of presentation in instructional sequence.

Another form of prior information, other than objectives, which was investigated was the use of graphics or visual aids. The study centered on prior knowledge of Program Evaluation and Review Techniques (PERT) on matching written paragraphs to PERT networks. The results are valuable in suggesting the use of visual organizers for use by learners.

*Effects of anxiety and interrelationships to learner strategies.* In a continuation of research performed over the last several years on the interaction of state anxiety and task/learner variables, studies were developed to test anxiety effects in a computer-based educational system. The first of these tested the interaction of anxiety with the availability of objectives and/or test items on a computer-based instructional task. The results indicated that state anxiety could be reduced in learners by presentation of such information.

Two additional studies tested anxiety effects in computer-based testing situations. The first looked at item difficulty sequencing as it affected poststate anxiety. Although levels of state anxiety were not significantly different, the hard-to-easy sequencing effects were in the direction of anxiety reduction, while easy-to-hard sequencing was in the direction of increasing poststate anxiety.

*Effects of response mode on learner strategies in programmed instruction and CAI tasks.* One of the explicit assumptions about the advantages of programmed instruction and computer-assisted instruction is the requirement on the student to respond overtly. The response forms commonly used, multiple-choice and constructed response, have received some degree of study as to relative effectiveness. A review of this issue was performed to determine the present state of these findings. The results of the review suggested that the constructed response mode was superior when content familiarity was low, or when low program redundancy was evident. These findings suggested that the greater effectiveness of constructing responses may be a function of forcing students to attend to instructional material for longer time periods than in other response modes.

In an effort to test this possibility a study was performed which tested the effects of distraction on both constructed response and reading modes. The only significant effect on instruction was that constructing responses led to higher achievement than

only reading the material regardless of distraction. Thus, interrupting the task, thereby interrupting attention to learning materials, did not reduce the relative effectiveness of constructing responses.

**Training Strategies**

The emphasis of study within the area of training strategies is on new techniques for design, development, implementation, and evaluation of computer-based instruction and instruction management. The major goal in this research is to identify those procedures and techniques which move nearer to optimization of the instructional process. The thrust of effort recently has been in two general areas. First, an attempt has been made to further a systematic approach to instructional development. Secondly, studies were performed that represent implementation of findings from previous learner strategy research into instructional design. The rationale for the second step is that unless such findings are implemented, they are less worthwhile than is implied in the endeavor to improve the educational process.

*The systematic approach.* Systematic approaches to education are meant to refer not only to the systematic development of instruction, but also to a systematic and controlled instructional environment. The latter aspect of systematizing resulted in the implementation of project FOCUS (Florida State University On-Line Coordinate Index Use Study). About 150 students from the School of Library Science have used FOCUS in 1972. FOCUS is an on-line searched information retrieval system developed jointly by the CAI Center and the School of Library Science. The system includes features of indexes now under development, and is an attempt to model information retrieval systems that the students are likely to encounter in their professional careers. Students are using FOCUS in two courses. The system is demonstrated in the introductory information science course. FOCUS is also used as an aid in teaching indexing and index evaluation in the abstracting and indexing course. FOCUS is one of the first on-line searched information retrieval systems in library schools. Students reaction and comments in the library profession have been favorable.

Another effort was concerned with the development, implementation, and empirical testing of a revision model for systematically designed materials. The basis of the study was the concern that data are needed to warrant the longstanding assumption that systematic design approaches insure that a high proportion of students reach mastery. Findings uphold the assumption.

While systematic approaches to many forms of instruction have been in existence for some time, the development of simulations has had a lack of techniques available. With special interest in computer-based instructional simulations, but with a goal of generality, the CAI Center developed a systematic approach to simulation design, implementation, and evaluation. The approach is intended to make simulation a more instructionally effective and economically viable tool for education.

One of the problem areas in education, counseling, and psychological diagnosis has been the bottleneck of systematically administering tests such as the Minnesota Multiphasic Personality Inventory (MMPI). The FSU CAI Center implemented the MMPI on a computer-based system such that many testees could be administered the test

at once with little or no guidance from a testor. In an effort to determine the relative effectiveness of the computer-based testing, the computer testing was compared to the booklet version. Results indicated that, compared to the booklet version, the computer mode was as good as or better than alternative administrations such as cards and booklet-booklets.

*Learner strategy implementation as training strategies.* Pacing, or the control of information presentation rate, is one potentially important dimension in training strategies as well as learner strategies. It is well within the present capability of most computer-mediated instructional systems to individualize the presentation rate of material based on individual student performance in the particular instructional situation. However, little is known about strategies for performance-based information presentation rate. In an investigation of pacing strategies a performance-based pacing algorithm was employed whereby reading rate was adjusted on the basis of frequently assessed immediate recall. The performance contingent condition resulted in faster reading rates, lower immediate recall scores, and slightly lower retention scores than a self-paced condition (learner control of pacing).

Another study investigated the effects of organization of reading materials. It is possible to consider as learner strategies the subjective organization of a learner. Given subjective organization as a learner strategy, the effort should be made to develop appropriate training strategies. This study was concerned with the nature of subjective organization and its relationship to learning from organized and unorganized prose. The results indicated that individual differences do exist in associative memory and subjective organization processes such that designers of instruction should consider the possible interaction between cognitive process variables and instructional presentation rates.

A systematically developed course, utilizing findings of learner strategy research, was implemented as a computer tutorial review for an introductory college physics course. It has been used, on a voluntary basis, by over 500 students over a period of several years. Analysis of effectiveness showed the students using computer materials as performing significantly higher than the class as a whole. However, this computer-based training strategy effectiveness was in question because of the possible selectivity of volunteers. An investigation of the selectivity was performed indicating that the difference in effectiveness is not primarily due to a factor of selection.

Another study sought to look at some of the learner strategy variables, mentioned under that section, in terms of training strategies. This study sought to test the interpretation that high test anxiety students perform more poorly on difficult material, because they divide attention between personally relevant and task relevant concerns to a greater degree than low anxiety individuals. In this study latency data showed no difference between high and low anxiety subject and the hypothesis was not supported. On the basis of this one study the conclusion would have to be that difficult material is acceptable in training strategies with relation to high anxious students.

**Computer Systems Strategies**

*System development.* A sixth 1810 disk drive was added to the IBM 1500 system. The reason for adding this additional drive was to provide greater flexibility in course scheduling and to allow better utilization of the total system by having more courses available at any given time. The addition of the drive necessitated modifications to several programs in order to utilize this additional memory. The modifications were primarily oriented toward recognition of the six available drives such that the sixth could be read and written. Modifications were necessary to (a) the IBM CAI operating system, (b) the DISKL L/O routine of the CAI Center's off-line library, (c) the 1800 assembler (ASMBL), and (d) the $EXIT routine of the Center's disk monitor system. Several data management program systems which utilize disk tables to track the status of disk packs themselves were also modified to recognize the six drives.

A core image format (CIF) card deck producer was written to facilitate the system building. The ISS disk monitor system deals primarily with relocatable format programs and therefore no need previously existed for the core image decks.

Programming experiments carried out with the interval timers (part of the IBM 1800 CPU hardware) indicated that it was possible to include a subroutine which could tally off-line programs execution times for output to the printers. The value of a self-timing mechanism embedded in programs is that: (a) during systems development alternate programming methods could be compared for efficiency, and (b) more accurate computer time accounting is possible. The latter reason was especially important since the original IBM operating system does not allow at all for time accounting of users or jobs. Two separate library subroutines were written. One, CLKON, uses one interval timer and one time accumulator to keep track of the total execution time of an off-line job. The second, JOBON, uses two interval timers and two time accumulators and is capable of timing unlimited nonoverlapping tasks within a job while simultaneously keeping track of the total job execution time. CLKON is to be used for normal time accounting, while JOBON is used primarily during softwork development.

Work was also necessary to insert these two library subroutines in those programs for which it had the most value. These included most of the data management programs such that the time accounting and auditing could be more precise. Approximately 30 programs had one or the other of the accounting subroutines added to them. During incorporation of these execution timing subroutines, minor bugs were found in some system programs, including the tape error handling sections of a tape copy program TCOPY and the TDUMP. These were corrected as discovered. One program, the Data Management System merged program MERGE, became too large to fit in the core as it was currently organized when the programming execution time subroutine was added. It was necessary therefore to implement a major rearrangement of the program's organization in order to fit it into core with inclusion of the program title routines.

One of the noted inefficiencies of previously developed programs was that the garbage routine of the disk filing handling package (GRBGE) did not adequately garbage collect when programs were deleted and added to the system. The routine was therefore modified to garbage collect a disk by combining adjacent free files. The routine was

also rewritten to sort the entries and the directory to descending order by file address and to combine these adjacent free files. This allows provision for better disk space utilization through the minimization of checkerboarding.

Modifications and debugging were performed for several of the CAI Center development programs as normal maintenance programming activities. These included:

1. The modification of the DELETE/SELECT program to utilize five characters instead of only four in searching for the course name. This allows the data management system to operate on five character courses instead of four character courses. Originally, the program should have operated on five characters and this was a design error.

2. The program which is used to move and back up (on tape) the CAI users files, UTP, was discovered to have a bug which caused loss of some files during moving. This was corrected.

3. LSPDA is the program which lists on the 1443 printer the CAI directories of any disk packs which are mounted and ready on the system. This program was modified to print the location and length of each free file and to print the total available free space on each disk. This allows the operations personnel to better plan and organize course program storage, and thus to better schedule courses and students.

4. The STORE program which stores programs on the ISS monitor disk was modified to do less printing on the 1443 printer and to update the directory on disk only after all programs in the job were stored. The effect of these changes is to provide faster execution times for the STORE program. Two options were also added: (a) an option to allow the user to obtain the printing of data which would normally be suppressed, and (b) to call the ISS directory list program LSTDR after the completion of the STORE program.

*Documentation.* Documentation of the APL system (A Programming Language) proceeded with the completion of Systems Memo 15 "Operation of Off-Line Programs for Generating and Maintaining the APL/1500 System." The development of that systems memo completed the documentation for APL. That is, all users and operator's guides have been satisfactorily documented.

In addition, the programs on the chart below have gone through the current documentation effort.

PROGRAM DOCUMENTATION STATUS

STATUS SYMBOLS: X = DOCUMENTATION COMPLETE
O = USER MANUAL ONLY

X 1. PROGRAM DOCUMENTATION GUIDE
2. SYSTEMS OVERVIEWS (in progress)
3. REPLACED BY 2
4. REPLACED BY 2
5. LOADR (FIRST DRAFT COMPLETED)
X 6. INITZ
7. STORE

X 8. GARBG COLLECTOR
X 9. DELET
X. 10. LSTDR
X 11. BOOTSTRAP & BOOTP
X 12. $EXIT
X 13. EXIT
X 14. DMS SUPERVISOR
X 15. MERG2
X 16. DELS
X 17. SORT 2 (PHASE I OF THE SORT)
X 18. FAZE2 (PHASE II OF THE SORT)
X 19. DPRNT
20. RAS (FIRST DRAFT COMPLETED)
X 21. PTTTP
X 22. PTTTP SUBROUTINES
X 23. TPLST
X 24. ASMBL
X 25. TPDSK
X 26. WIPE
X 27. LSTDK
X 28. IDXSB
X 29. SCANNING SUBROUTINES
X 30. GRBGE AND OTHER FILE ROUTINES
31. DISKL (FIRST DRAFT COMPLETED)
X 32. BTALK
X 33. XLATE
X 34. GTAPE
35. UFTTP (FIRST DRAFT COMPLETED)
X 36. DEADFILE UPDATE
X 37. DMS TAPE LIST
X 38. CONSOLIDATION
X 39. RECNT
X 40. C2T , T2C
X 41. STLST
X 42. RIMBIN: TSS/8 LOADER
43. PNCHC
44. TDUMP
45. TCOPY
X 46. WAKE & WAKS
X 47. CLKON & CLKOF
X 48. JOBON (COMPLETED)
49. CORIM
50. RESPN
51. CNTPI
52. DMSTL

53. DATCH (FIRST DRAFT COMPLETED)
54. CDATE (FIRST DRAFT COMPLETED)
55. TTIME
56. FOXPT
57. ITEM ANALYSIS
58. PERT
59. PRINT LABELS
60. GUERRY UTILITY PROGRAM
61. WRITE TAPE MARK
62. SEQUENCE PUNCH
63. CDLST
64. DISK COPY
65. CARD REPRODUCE
66. CNEDT
67. TYPIN

0 68. SWICH
0 69. DATE
0 70. BINE
0 71. SETBT
0 72. DBLHX
0 73. EBIN

## Abstracts of Studies

In the year 1972, 19 publications were issued from the CAI Center, Florida State University, intended to communicate the research findings from studies and sponsored projects that have direct implications for the role of computers in education and training. CAI publications are classified primarily as systems memos (SM), technical reports (TR), or technical memos (TM) depending upon the nature and extensiveness of subject treatment. Beyond that primary classification, each of the publications is grouped into major component strategies. These strategies are: learner strategies, training strategies, and computer systems strategies.

Abstracts of the 19 publications in 1972 are presented according to the major component strategies.

### Learner Strategies

TM44. Tobias, S. *Review of the response mode issue*, 1972.

The purpose of this paper was to review some of the investigations concerned with the effectiveness of different modes of responding to programmed and computer-assisted instruction. The findings suggested that when student familiarity with program content is low, or when there is little program redundancy as determined by the blackout ratio, constructed responses lead to higher achievement. Problems with the use of the blackout ratio are discussed. It is suggested that the greater effectiveness of constructing responses in some cases may be a function of the fact that students are forced to attend to the instructional material for longer periods of time than in other response modes.

TM45. Duchastel, P. & Merrill, P. *The effects of behavioral objectives on learning: A review of empirical studies,* 1972.

The purpose of this paper was to review the literature dealing with the effects of communicating behavioral objectives to students. Over 25 empirical investigations were reviewed in detail.

The first category of studies analyzed involved those investigations which addressed the general issue as to whether providing advanced knowledge of behavioral objectives to students facilitates their learning. Positive effects on posttest performance were reported in 5 of 10 studies, while a facilitative effect on retention performance was found in two out of three instances.

A second group of studies sought an interaction between the availability of objectives and type of learning. Only two of the seven studies found an interaction. The first reported a facilitative effect on knowledge acquisition, but not on comprehension; the second study reported an interfering effect for objectives on a problem-solving task, but not on a discrimination task.

A third group of studies sought interactions between the availability of objectives and learner characteristics. Interactions were reported with reasoning ability, personality characteristics, and state anxiety.

Finally, a fourth group of studies investigated the effect of the availability of objectives on the time required to complete the learning task. Coupled with learner control, objectives reduced learning time, but alone, objectives either had no effect or increased learning time.

In the concluding section of the review, the content of the issue of within instructional theory is discussed, as well as the rationales which predict a facilitative effect on learning. Problems involved in research on objectives are also discussed and a direction for future research is suggested.

TM46. Towle, N. & Merrill, P. *Effects of anxiety type and item difficulty sequencing on mathematics aptitude test performance*, 1972.

Effects of item difficulty sequencing on performance and on poststate anxiety were investigated using a timed mathematics aptitude test. The subjects were randomly assigned to a random, easy-to-hard, or hard-to-easy item difficulty sequence group. The hard-to-easy sequence group performance was significantly lower than either the random or easy-to-hard sequence groups. Though not statistically different the mathematics aptitude test scores of four achievement anxiety types grouped using the Achievement Anxiety Test, and levels of state anxiety provoked by the three difficulty sequences were in the predicted direction.

TM47. Merrill, P. & Towle, N. *The effects of the availability of objectives on performance in a computer-managed graduate course*, 1972.

The effects of presenting objectives to students in a graduate computer-managed course were investigated. The 32 subjects who registered for the course on Techniques of Programmed Instruction were randomly assigned to an objective group and a no-objective group. The hypotheses, based on previous laboratory studies, that objectives would decrease test item-response latency, increase study time, and facilitate performance on unit tests were not supported. Objectives did significantly reduce state anxiety; however, even that effect diminished as the course progressed. Apparently graduate students are able to "psych out" a course very rapidly, and objectives have little effect.

TM49. Tobias, S. & Hedl, J. *Test anxiety: Situationally specific or general?*, 1972.

This study reports two experiments whose purpose was to relate two bodies of research on anxiety: test and trait-state anxiety. It was reasoned that state anxiety measures obtained in an evaluative testing condition should be more similar to test anxiety, than state anxiety measures obtained in nonevaluative situations. The results of both experiments failed to confirm this hypothesis. Test anxiety was less sensitive to fluctuations of evaluative stress than state anxiety, and more closely related to general trait anxiety.

TM52. Tobias, S. *Distraction, response mode, anxiety, and achievement in CAI*, 1972.

In this investigation the effects of distraction, mode of responding to CAI material, and anxiety were studied, as was the interaction among these variables. A total of 121 subjects was used in a two-by-two design, defined by a distraction and nondistraction condition, and constructing responses as opposed to reading the program. The effects of these conditions and their interactions with test anxiety were determined by multiple linear regression analysis. Finally, the effect of these conditions on state anxiety was assessed at four points in the instructional and test sequence. The

only significant effect on instruction was that constructing responses led to higher achievement than only reading the material. State anxiety was higher for all groups in which an overt response was required. The findings suggest that decrements in achievement attributable to distraction are more accurately interpreted in motivation terms.

TM57. Tobias, S. & Duchastel, P. *Behavioral objectives, sequence, and aptitude treatment interactions in CAI*, 1972.

The effects and interactions of behavioral objects, sequence order, and test and state anxiety were investigated. The results indicated that there were no main effects attributable to objectives. It was expected that providing students with program objectives would have no effect in the logically organized program, but that the achievement of students receiving objectives and a scrambled program should be facilitated. This interaction between objectives and sequence was not supported by the results. As expected, attitudes towards the program were more positive among students taking the logically sequenced material compared to those receiving the scrambled sequence. The fact that state anxiety was unaffected by either objectives or sequence was unexpected.

TM59. Merrill, P., Steve, M., Kalisch, S., & Towle, N. *The interactive effects of the availability of objectives and/or rules on computer-based learning: A replication*, 1972.

To replicate and extend the results of a previous study by the principal author, this study investigated the effects of behavioral objectives and/or rules on computer-based learning task performance. The 133 subjects were randomly assigned to an example-only, objective-example, rule-example, or objective-rule-example group. The availability of rules and/or objectives reduced the number of examples required to meet criterion performance and increased posttest performance. In addition, rules reduced display latency and test item response latency, and increased retention test performance. Rules also decreased the level of within-task state anxiety.

TM60. Dunn, T. & Hansen, D. *Learning by graphics: Translating verbal information into graphic network formats*, 1972.

This research attempted to gain more information about how visuals are processed given the effect of prior knowledge of Program Evaluation and Review Techniques (PERT) on matching written paragraphs to PERT networks. The dependent variables of proportion correct, latency and branching were studied with groups (prior knowledge and no-prior knowledge) and items (repeated measure) as independent variables. Results were most valuable in pointing the way to further research dealing mainly with the meaningfulness of graphics or visuals.

TM61. Merrill, P. & Towle, N. *Interaction of abilities and anxiety with availability of objectives and/or test items on computer-based task performance*, 1972.

The effects of behavioral objectives and/or criterion test items on the learning process were investigated. The 123 subjects were randomly assigned to either an example-only, an objective-example, a test-example, or an objective-test-example group. Objectives significantly

increased the amount of time subjects spent studying the example displays. A significant ability by treatment interaction revealed that display latency had a negative relationship to reasoning ability for subjects in the test-example and objective-test-example groups, but was not related to reasoning for subjects in the example-only and objective-example groups. Differential relationships between state-anxiety and treatments were also observed.

TM66. Duchastel, P. *Incidental and relevant learning with instructional objectives*, 1972.

It was hypothesized that one role of objectives in learning was to serve as orienting stimuli by which the learner could decide on the time to devote to study materials. With a brief text to learn, 58 college students received either one-half of the 24 objectives for the text, or no objectives at all. As expected, the subjects with half of the objectives performed better than their counterparts without objectives on the posttest items referenced to their objectives (relevant learning), and less well on the items not covered by their objectives (incidental learning). That these findings conflict with previous research results with respect to incidental learning, could result from the fact that the subjects in the study had practical experience with an objective-referenced instructional model.

**Training Strategies**

TR24. Rayner, G. *An empirical study of a methodology for the revision of systematically designed educational materials*, 1972.

This study involved the development, implementation, and empirical testing of a revision model for systematically designed educational materials. The investigation provided needed empirical evidence that given a revision subsystem, instructional materials and course operational procedures can be developed which insure that a high proportion of students reach a given level of mastery.

TM48. Lushene, R., O'Neil, H., & Dunn, T. *Equivalent validity of a completely computerized MMPI*, 1972.

Within the context of a counterbalanced design, 63 female students were tested with a computerized MMPI and a group booklet mode of administration. State anxiety was measured before and after each testing session. The computer-based MMPI scale scores were shown to correlate as high or higher with the booklet administration scores than correlations reported for comparisons between booklet and card form administrations or booklet-booklet administrations for a college population. When compared to the booklet version, the computer mode initially produced relatively high state anxiety levels. By the end of the test, however, no difference in state anxiety levels between the two modes of administration was found.

TM54. Hansen, D., Manning, P., & Johnson, B. *A systematic approach to learning simulations*, 1972.

In view of the growing interest in and use of instructional simulations, the CAI Center developed a systematic approach to their development. This approach is described in this document, including references to literature sources and to simulations already developed in the Center. Historical

background, problems, and advantages of the use of instructional simulation are covered, and numerous definitions of often-used terms are included. The document concludes with a complete listing of the instructional simulations now in various stages of development at the CAI Center. Graphs are used to give overall views of the current standing of each simulation, and of the range of target populations suggested for each.

TM56. Tobias, S., Hedl, J., & Towle, N. *Latency and test anxiety*, 1972.

This study sought to test the interpretation that high test anxiety (HA) subjects performed more poorly on difficult material because they divided their attention between personally relevant and task relevant concerns to a greater degree than low anxiety (LA) individuals. It was reasoned that such division of attention ought to require more time for HA students on difficult items, and, hence, should result in higher response latency. A mathematical aptitude test containing both easy and difficult items was administered to 80 subjects. Analysis of variance indicated that HA students performed more poorly on the difficult sections than LA individuals. However, the latency data failed to confirm the hypotheses.

TM64. Kromhout, O. *Effect of computer tutorial review lessons on exam performance in introductory college physics*, 1972.

Computer tutorial review lessons for a one-quarter lecture course in introductory college physics have been developed and used by approximately 500 students, on a voluntary basis, over a period of several years. The investigation shows that the exam grades of students who used the computer materials were significantly higher (.01 level), than the class as a whole, if results from sections are pooled. Evidence is presented to show that this is not primarily due to a factor of selection because of the voluntary basis for participation.

**Computer Strategies**

SM15. McMurchie, T. *Operation of offline programs for generating and maintaining the APL/1500 system*, 1972.

The document describes the operation of the offline programs necessary for generating and maintaining the APL/1500 system. APL/1500 is a conversational timesharing system that supports up to 32 terminals. The system is a stand-alone program package which is distributed in the form of punched card decks. The user is assumed to be familiar with all hardware operating procedures.

TM26. Rivers, L. *Development and assessment of an adaptive strategy utilizing regression analysis techniques for the presentation of instruction via computer*, 1972.

The objective of this investigation was to develop and assess a methodology for adapting self-instructional materials to individual differences among learners. In this two-phased empirical approach, on-going performance was monitored and used to predict final achievement. Adaptations

were made in the course content for each individual as the instruction proceeded in order to optimize his performance. The results of this study have revealed the potential of an adaptive strategy for the presentation of instruction which utilizes regression analysis techniques.

TR27. Motley, D. *An on-line computer managed introduction to indexing: An individualized multimedia instructional package compared to the traditional method, nine hours of teacher-group contact*, 1972.

A systems approach model was used to develop a multimedia instructional package for a three-week unit on indexing in a graduate library science course. The instructional package consisted of various combinations of media determined by following a curriculum model. The specific media combinations were cassette tapes, two-by-two slides, sample indexes, specimen index cards, computer-assisted lessons, a programmed text and other suggested readings, search exercises with computer, and manually-searched indexes, a scheduled seminar with the professor, and optional individual as well as small group conferences.

The multimedia instructional package was tested in two experiments. In the first experiment, performance and attitude of students exposed to the traditional, teacher-oriented method, and to the multimedia method were compared. The multimedia method was used in a second experiment with another group of students.

## FEDERAL AND STATE FUNDED PROJECTS

**Improving Social Work Education through Computer Instruction** (HEW Social Rehabilitation Services)

Two courses were tested this past year using CAI technology, computer simulations for problem-solving and programmed instruction. One programmed text to be used in conjunction with a course in mental retardation is being published and will be available to the general public in April, 1973. A second programmed instruction has been tested and is now being used by students in a course on human services administration. Cathode ray tube and teletype terminals are being used to present the student with simulations of problems in human services administration.

Students were asked to respond to end-of-the-course questionnaires indicating their reactions to seven teaching components. On this 7-point scale programmed instruction received the highest rating as a major component of learning as related to the course. Lectures and outside reading were perceived as having provided the least amount of learning. In addition, the programmed learning was received favorably over other methods.

The grant was completed in December, 1972, although some of the research will be continued especially in respect to computer simulations of administrative problems.

**Improving Youth Vocational Opportunity through Parent Counseling** (United States Office of Education, Title I Project)

The Parent Counseling Title I Project's primary goals are: (a) to provide competencies to each parent so that they may counsel their children, and in so doing provide supportive assistance to their child's vocational maturation, and (b) to acquaint each parent to career possibilities as a paraprofessional "occupational specialist." To realize these goals, personnel from the Department of Adult Education and the Center for CAI are jointly developing computer-managed instructional materials.

Faced with a learner population with limited reading skills, emphasis has been placed on developing nonprint instructional materials. Developmental activities have produced the following: a 10-minute color documentary film on Lively Vocational Technical Center; a videotaped panel discussion with personnel from the county supervisor's office on the subject of guidance services offered by the county school system; a three part slide/tape series on the structure and trends of the labor market; videotaped U.S. Department of Labor public service announcements on job discrimination and racial prejudice; a matrix describing available sources of low cost education financial assistance; an overhead transparency sequence of job families, keyed to job classifications in the Dictionary of Occupational Titles; and correspondent on-line evaluation activities.

Eight instructional sessions were held at each of the following locations: The Philidelphia Primitive Baptist Church and the Human Resources Clearing House, Tallahassee, Florida. All evidence suggests a high level of interest and enthusiasm for the CMI paradigm. Moreover, such attitudinal sets support the viability of the CMI instructional strategy among adult disadvantaged learners.

All project experiences are currently being compiled into a Project Final Report. The current projected release date is in the Spring, 1973.

**Analysis and Development of Adaptive Instructional Models for Individualized Technical Training** (United States Air Force)

The CAI Center was awarded a contract by the Air Force Human Resources Laboratory (AFHRL) to perform an analysis and development of Adaptive Instructional Models (AIM) for individualized technical training. The AIM will serve as representation of the characteristics and operations of the Air Force's proposed Advanced Instructional System (AIS). The principal benefits of the AIM are the clarification of adaptive training processes and the provision of the conceptual basis of this individualized form of technical training.

The AIMs will have four properties that promote the individualization of the training process: adaptiveness, contingency, mediation, and cybernetic.

The objectives of AIM can be stated as follows: (a) to provide a fine-grained monitoring of each student's performance; (b) to provide a set of training decision rules that optimize students' motivation and progress; (c) to provide a decision allocation procedure that optimally assigns instructional media, material, and incentive rewards according to each student's characteristics and performance; (d) to provide predictions

of performance and time parameters for both the highly successful as well as the deficient students; and (e) to provide for the scheduling of all instructional resources to lead to a minimization of cost.

The first phase of the contract consisted of performing a detailed literature search and identifying various adaptive instruction models. These models dealt with drill and practice, simple concept acquisition, rule learning, problem-solving, algorithmic regression, dynamic programming, natural language, and automata models for adaptive instruction.

During the second phase of the contract, three models were simulated. These were a drill and practice model, a performance-contingent pacing model, and the algorithmic regression model. The simulations serve to (a) concretize and operationalize the concepts and the models, (b) suggest the proper use and ranges of model parameters, and (c) provide the first look at the AIS adaptive model data base and its operation. Once AIMs are implemented within the AIS, the models will continue to evolve and change, given evaluative feedback.

**Air Force Reassignment System** (Air Force Human Resources Laboratory)

The Air Force system for the distribution of personnel involves the reassignment of a significant proportion of the enlisted force each year. In general, reassignments of persons into vacant positions are controlled by the classification structure. Both persons and positions are identified in terms of Air Force Specialties (AFSC). Appreciable evidence has been developed through research carried out by the Air Force Human Resources Laboratory Personnel Research Division which indicates that jobs within an AFSC are not identical. Analyses of jobs, using information at the task level of detail, clearly demonstrate that there are clusters of jobs within many of the AFSCs that are relatively similar to each other, while others in different clusters may overlap in terms of tasks performed.

An assumption underlying the research carried out under this contract was that there is some loss of productive time as a result of a reassignment action. The lost time referred to is limited to the nonproductive or marginally productive time spent in a new assignment while learning to perform those tasks not previously in the incumbent's repertoire. The greater the dissimilarity between the tasks performed in two successive assignments, the greater the amount of nonproductive time required during the second assignment to efficiently perform the entire job.

Another objective of a reassignment system is that of career-broadening. Career-broadening is the process by which career personnel in the enlisted force are exposed to a broad range of the work performed within the specialty, and which prepares supervisors and superintendents for these management positions.

The purpose of this study was to investigate the feasibility of implementing an advanced reassignment system for Air Force enlisted personnel. The research is focused on the possible use of occupational survey data in the management of such a system. The primary product of this research is a cost-effective analysis of the operation of an advanced reassignment system based on job information at the task level of detail, and recommendations resulting from this analysis with respect to the use of occupational

survey data. The analysis will include, but not be limited to, the evaluation of nonproductive time resulting from the reassignment of personnel and the offsetting of costs which may result from career-broadening. The results and recommendations of this contract are expected to provide the basis for further research. It will identify elements of the overall project to which specific studies and research should be addressed.

**Public Service Careers Program** (U.S. Department of Labor)

Public Service Careers Program activities were initiated in 1970 by the Manpower Administration, with the intent of developing employment opportunities in public agencies for disadvantaged persons, and upgrading current employees in certain cases. Florida State University, seeking to broaden its staff training base and to stabilize and improve its working force drawn from the disadvantaged community, began its PSCP project in July, 1971. Its activities consisted of human resources development and training. The staff was involved, therefore, in studying the structure of the university and recruiting and placing disadvantaged individuals in the work force. These staff members then took part in the individualized training program, which centered upon computer-assisted and computer-managed instruction.

By the end of 1972, 45 participants in the program had been placed on the university staff, and were provided with training opportunities which included basic skills, job skills, work adjustment skills, and individual and group counseling. Additionally, the project staff worked consistently at locating and providing supportive services which reduced the barriers often found to prevent many individuals from finding or retaining employment.

When the project terminates in 1973, evaluation will include effects of and attitudes toward computers in instruction, effects of the training program on employee evaluation and retention, and overall assessment of the potential of such manpower programs.

**The Wakulla County Program for Curriculum Development through the Use of Computer-Assisted and Computer-Managed Instruction in Reading** (U.S. Department of Health, Education, and Welfare Title III Project)

In cooperation with the Wakulla County, Florida School Board, the Center completed the development and evaluation started in the Fall, 1971 of computer-assisted instruction reading materials designed for use by Educable Mentally Retarded (EMR) students.

The CAI program was the first of a three-phase effort designed to serve between 60 and 70 EMR students in three elementary schools and one high school. The second phase involved the development and evaluation of a computer-managed instruction program in which the computer was used only for evaluations and prescriptions. In Phase III, a curriculum will be developed which does not involve computers.

The Phase I materials were prepared on four reading levels. Each student's progress was monitored daily, and each was assigned to the level suggested by that evaluation. The investigators found that the difference between the third and highest levels was too broad, so a new program was developed and evaluated to bridge that gap.

In addition, an experiment was designed to test the effects of picture-stimuli on vocabulary acquisition. The study demonstrated that picture-word matching significantly improved the student's ability to learn new words.

In September, 1972, Phase II began with the writing of programmed booklets to be used in the CMI program. Many materials were written to eliminate gaps found during the Phase I evaluation. A new branching technique was developed which was based on a hierarchical development of reading skills.

Also included in the materials were picture-word matches suggested by the study in Phase I, but the concept has been expanded to include picture stimuli to be matched with phonetics, phrases, and sentences.

Evaluation of Phase II will be completed in the Spring, 1973. Phase III, which will begin in the Fall, 1973, should result in noncomputer, individualized materials which can be used by EMR students throughout the State of Florida.

**A Needs Assessment of Programs Serving Mentally Retarded Children and Youth in the Florida Public School System** (Dept. of Education, State of Florida)

In an effort to assist in realizing one of the components of the Florida Department of Education's 1972 Planning Model, the Center was contracted to conduct a needs assessment of the current financial, material, and manpower needs of mentally retarded children in the Florida public school system. It was agreed the CAI Center would develop a needs assessment instrument, collect quantitative data, conduct on-site visitations at least at 1/3 of the school districts, and present a Final Report by 31 March 1973.

The functional goal of the needs assessment component was to present a solid body of data to satisfy the first phase of the planning model by providing reliable management information. In addition, the needs assessment was seen as an empirical-rational approach to planned change in that it was intended to bring about the conscious utilization and application of knowledge as an instrument for modifying institutional patterns and practices.

The needs assessment instrument and the on-site visitations will provide the field with a formal mechanism with which to report existing deficits in its educational planning system as well as an opportunity to communicate perceived priorities in keeping with local needs.

**Concept Acquisition** (Department of Health, Education, and Welfare)

Initiated in March, 1972, the Concept Acquisition project's major objectives were to study variables and conditions that appear to have a direct application to the design of concept acquisition instruction. Three task variables were identified that could be manipulated by the instructional design to produce an optimal information processing strategy. The three variables are stimulus similarity, prompting procedures, and sequence of instances.

The stimulus similarity paradigm involved organizing examples and nonexamples of a concept class by pairing divergent examples and matching these examples with

similar nonexamples (i.e., those having similar irrelevant attributes). This organization paradigm has facilitated concept acquisition in previous studies, and is included in these studies as an attempt to replicate.

The concept in Experiment I was trochaic meter (poetry). In addition to the stimulus similarity paradigm, some students received a verbal prompt condition, resulting in a two-by-two factorial design with two levels of organization (organized and random) and two levels of prompting (availability and no-availability). The task was presented to ninth and tenth graders and later to college students on teletype terminals, interfaced to the IBM 1500 at the CAI Center by a Digital Equipment Corp., PDP-8 680 Communications System. Correct classification, overgeneralization and undergeneralization scores on a posttest, and multiple latency measures served as the dependent measures. Little learning occurred with the high school students, a result attributed to their lack of familiarity with poetry and with the prerequisite meter concept. However, the college students learned in all treatments, and differences across groups were found in the types of errors made and on the latency scores.

In Experiment II, college students were taught how to identify $RX_2$ crystals from paper-pencil instructional materials. In addition to the experimental conditions used in Experiment I, availability of prompting was subdivided into two prompting conditions. One condition pointed out only the critical attributes, or lack of those attributes, in each instance presented. This type of prompting was similar to the prompting in Experiment I. The second condition included these prompts, but also showed comparisons across instances, that is, the divergency between example pairs and the similarity between example and nonexample pairs was verbally pointed out. This latter type of prompting was thought to be especially helpful when crossed with the organized condition. Data are now being collected.

Experiments III and IV will measure the effects of different instance sequences on the correct classification, and on overgeneralization and undergeneralization scores on a posttest. Because CRT terminals at the CAI Center will be used, latency data will be available. The purpose of these two experiments will be to assess the effects of pairing divergent examples and of pairing similar examples and nonexamples separately on concept discrimination and generalization behavior. Data on these experiments will be collected during Spring, 1973.

Results from these studies will be provided to professional journals and will appear in a CAI Technical Report, probably available in the latter months of 1973.

## CURRENT GRADUATE PROGRAM

During 1972, 13 graduate students were actively pursuing a graduate study program. Current CAI Center graduate students (three) are members of the Instructional Systems program of the Department of Educational Research at Florida State University. The Instructional Systems program provides training in research development, and evaluation of instructional systems for promoting effective learning. The program also provides for specialization in the use of operation analysis techniques for developing means for

individualized instruction, multimedia instruction, and educational applications of computers. A groundwork in educational research methodology and evaluation is required of all candidates. In addition to formal coursework, hands-on practical experience in developmental research activity is required of all graduate students. Each student is assigned to a project as an integral part of the learning experience during his/her entire graduate program.

## UNIVERSITY SPONSORED ACTIVITIES

*Biology 201 review.* A lecture related educational experiment, involving a computer-assisted instructional (CAI) supplement, was conducted with two lecture sections of Biology 201 during the Fall Quarter, 1972. After the enrollment period, one of the two lecture sections was designated as the experimental section to which the CAI supplement would be available--the remaining lecture section did not have access to the program, as tight security was maintained. The CAI program was designed as a self-testing and self-study program patterned after the examination format, a modified multiple choice test in which each question was followed by five possible answer choices, more than one of which might have been correct. For the purpose of obtaining item analyses, the students were instructed to mark either yes (true) or no (false) for each answer choice. The CAI program was designed in the same fashion, so that while the student reviewed his knowledge of a particular area, he also became familiar with the testing procedure.

The CAI program was subdivided into six categories of subject material and the student chose any category for review. The first question in the category chosen for review was displayed on the screen along with the first answer choice, and the student was asked to determine whether or not the first answer choice was correct. If the response was incorrect, a statement as to the probable source of misinformation was displayed on the screen for the student's perusal. Once the feedback information had been reviewed, the student signaled the program and the second answer choice was displayed, appearing on the screen along with the question and the first answer choice. The student responded to the second answer choice as before. Any correct answer choice response was noted for the student by the appearance of either a capital "Y" (for a correct yes response) or a capital "N" (for a correct no response). Once the student had responded in this fashion to all five possible answer choices for a particular question, the question, its answer choices, and the student performance remained on the screen for review, until the student signaled the program to continue. Each review category consisted of 15 to 20 such questions, and the number of correct responses and the percentage correct was displayed on the screen following the completion of any category, thus providing immediate feedback on the student's most recent performance on that set of review questions.

The control lecture section will be compared with the experimental group to determine whether or not: (a) the CAI program improved student performance on cognitive and/or problem-solving questions; and (b) there is a correlation between the number of times the CAI program was used and the cognitive achievement of the student.

These data are presently being analyzed. The results of an attitudinal survey indicated that a majority of the respondents felt that the CAI program was very helpful.

*Health education.* The most extensive of the CMI courses, in terms of students processed, is the undergraduate health education course. This ample subject pool provided excellent resources for investigations of optimal training strategies within CMI. As a comprehensive goal, research centered upon performance-enhancing learner strategies which optimized CMI instruction. Basically, investigative efforts comprised of a series of programmatic studies in optimal course revision strategies and alternative prescriptive-remediation techniques within the CMI paradigm. Specifically, previous investigations have dealt with effects of selected instructional strategies on student confidence, study time, terminal time, studying strategies, mastery of objectives, curiosity, attitudes, and performance, particularly in terms of remediation/success criteria.

A total of 369 students in Health Education 319 were provided an on-going CMI program through the facilities provided by the CAI Center during the calendar year 1972. This service was provided in the winter, spring, and summer quarters only; in the fall this course was transferred with the newly formed Center for Computer Support of Instruction to the Florida State University Computer Center. Since this program was initiated in September 1970, CAI personnel provided the leadership, guidance, and much of the effort needed to make this an effective course. In December 1971, the CAI Center was instrumental in the preparation of an individualized, computer-managed drug education module for in-service elementary teachers. This was prepared for the State Department of Education, and received wide distribution in early 1972.

*Educational curriculum planning and administration.* The Department of Educational Administration (EDA) has used the computer-assisted instruction program for EDA 530 (430), Basic Concepts in Curriculum Planning, for the past several years. With few exceptions this material is used each quarter in order to teach students about the three basic types of curriculum organization. The EDA faculty believe the CAI program to be an effective teaching tool which holds the interest of most students. Two major values are the product of its use: (a) students learn material better than through presentation by lecture, there being no easily available source which they may read; and (b) many students have never seen such techniques much less used them, for this reason the students welcome an opportunity to learn through the CAI program.

The EDA faculty believe that FSU students, who will in coming years be in schools which will likely use computers, need an acquaintance with their use. This program provides such an experience.

*Physics review.* Computer review topics in introductory college physics were again made available on the TSS/8 computer during the Winter Quarter of 1972. The 55 review topics, each consisting of a series of multiple choice questions with tutorial feedback to the student, were developed in 1967, and have been used on a voluntary basis since then by students in Physics 107, a large enrollment one-quarter course for nonscience majors. During the spring quarter the review service was moved to the CDC/6500 computer at the FSU Computer Center, as part of the computer instructional services being administered through the Division of Instructional Research and Service (DIRS).

A study of students' exam grades over a period of five quarters in 1970-71 showed that students who used the review made better exam grades in the course than those who did not. Results of the study are presented in Technical Memo No. 64.

## COMPUTER-ASSISTED INSTRUCTION CENTER

The FSU CAI Center was involved in the university-wide reorganization program. In August, 1972 a portion of the Center personnel formed a new unit in the Division of Instructional Research and Service (DIRS), while the facilities and the main portion of personnel of the CAI Center were included in the College of Education.

Following are two lists of Center personnel. The first list is the personnel associated with the Center throughout the year 1972, while the second is a list of personnel associated with the Center from January - August, 1972, and who formed the new unit under DIRS.

**CAI Personnel 1972**

**Center Director**

Duncan N. Hansen, Ph.D., 1964, Educational Psychology, Stanford University, Associate Professor of Educational Research and Psychology, FSU.

**Associate Director**

Robert D. Tennyson, Ph.D., 1971, Psychology and Computer Science, Brigham Young University, Assistant Professor of Educational Research, FSU.

**Research Investigators**

Charles Adair
Marian W. Black
Walter H. Ehlers
L. R. Fox
John Hedl
Gerald Jahoda
M. C. Riser, Jr.
Sigmund Tobias

**Research and Support Personnel**

Beth Anderson
John Bennison
Bob Campbell
Dot Carr
Beckye Chason
Dwayne Clark
Bruce Freed
Ray Frost
Darryl Hall
Barbara Johnson
Debbie Johnson
Dewey Kribs
Barbara Leherissey
Steve Manieri
Dan Mann
Paul Manning
Gwen Mickens
Michael O'Halloran
Edna Reynolds
David Thomas
Doris Thomas

**Graduate Students**

| | | |
|---|---|---|
| Lela Buis | Tom James | Ron Rasco |
| Ed Durall | Leigh Kieffer | Michael Steve |
| Darlene Heinrich | Ora Kromhout | Peter Tam |
| Barry James | Paul Luyben | Susan Taylor |

**CAI Personnel (Jan. - Aug. 1972)**

**Research Investigators**

Bobby Brown
Paul Merrill

**Research and Support Personnel**

Bonnie King
Betty Wright

**Graduate Students**

Phil Duchastel
Stan Kalisch
Nelson Towle

**Equipment Configuration**

Florida State University's CAI Center currently supports three computers dedicated to research on all aspects of the use of computer technology for the furtherance of educational goals. Research on computer-assisted instruction, computer-managed instruction, CAI system development, testing paradigms, human learning, and other problems characterize this commitment.

Available equipment, as diagramed in Figure 1, includes an IBM 1500 Instructional System consisting of an 1800 central processing unit, a 1502 station controller, sixteen 1510 CRT displays, each with a keyboard and a light pen, one 1518 typewriter, and six 1810 disk drives with removable disk packs of 1,024 million bytes each. Additional peripherals include two 2401 tape units, one 1442 card read/punch, and one 1443 line-printer. Some pertinent technical specifications of the capacity and performance of the above date processing components are as follows:

1. The 1800 CPU has 32K 16-bit words and has a cycle time of two microseconds.

2. Each 1810 disk drive has a data transfer rate of approximately 36KB.

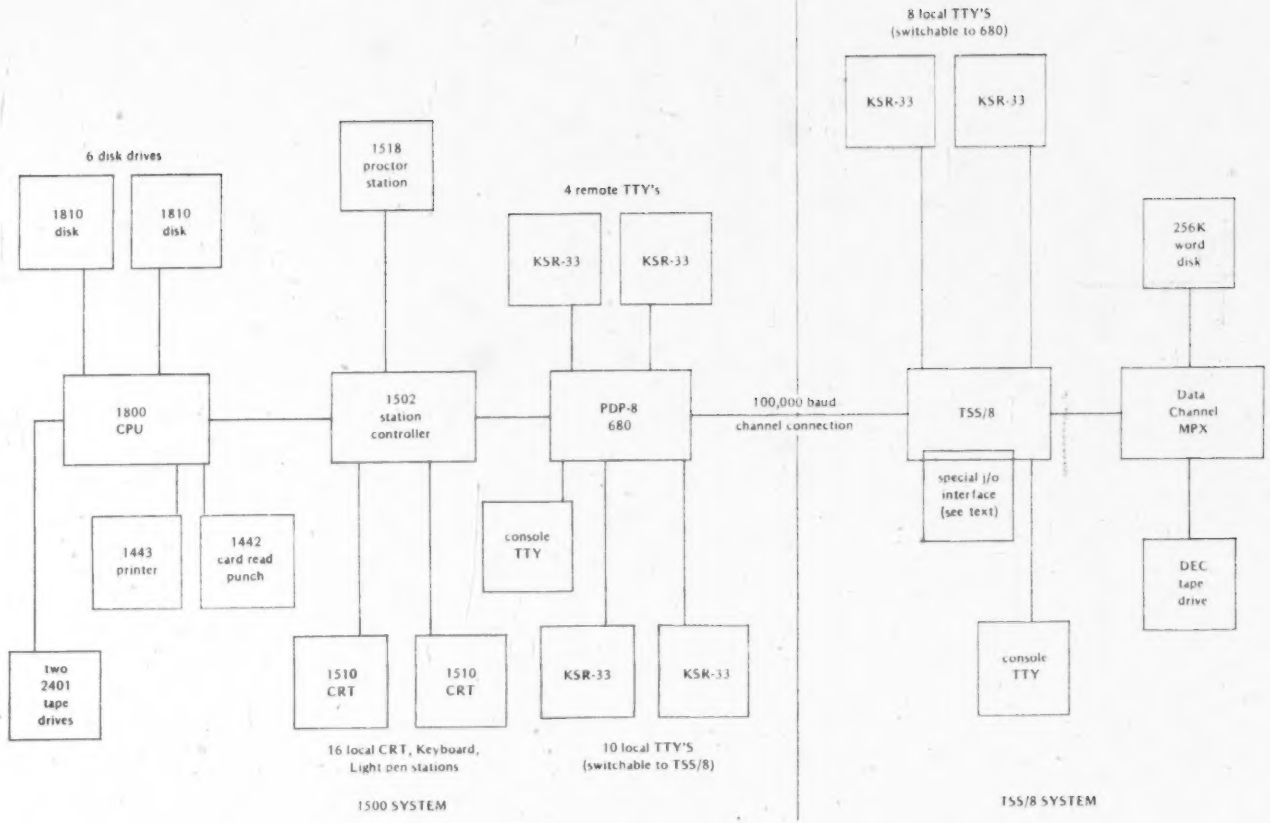


FIGURE 1. System Configuration

3. The 2401 tape units have a transfer rate of 30KB.

4. The 1442 card read/punch reads cards at the rate of 400 cpm and punches cards at a rate from 98 cpm to 390 cpm, depending on the number of columns punched per card.

5. The 1443 lineprinter has a character set of 52 characters, a line width of 120 columns, and a printing speed of approximately 240 lpm.

The second computer in the CAI Center installation is a Digital Equipment Corporation PDP/8 680 Communication System which is interfaced to the IBM 1500. The purpose of this is to provide the 1500 with a capability of supporting a mix of 16 remote or local teletypes. The 680 CPU contains 4K 12-bit words and has a cycle time of 1.5 microseconds. The teletypes operate at a rate of 110 baud.

The third computer is a PDP/8 TSS/8 timesharing which on its own supports 16 teletypes. The TSS/8 system includes a high-speed paper tape reader (300 characters per second), a high-speed paper punch (50 characters per second), one 256K-word disk to support the timesharing system, and a recently added DEC tape drive with a transfer rate of one word per 12.8 microseconds. The TSS/8 handles teletypes at the rate of 110 baud each. In addition, there is a 100,000 baud channel connection between the TSS/8 and the 680 to provide maximum flexibility of the system.

A special interface was added to the TSS/8 to control output to 64 binary electronic digital processes and 12 inputs from binary processes. For example, the TSS/8 can turn on or off 64 devices and receive on/off or yes/no input from 12 devices.

CAI Center equipment is equipped with an instructional support system for the 1500 system upon which all student responses are uniquely identified and recorded, and the Center staff has developed a data management system which compresses, sorts, merges, and summarizes this data for analysis purposes. The staff has also created a batch mode disk monitor system, the heart of which is a relocating, linking loader, and has developed special analysis programs in FORTRAN IV.

## APPENDIX A

### Publications

The following publications by the FSU CAI Center staff and students have appeared, have been accepted, or have been submitted during the period 1 January 1972 through 31 December 1972. In addition, the appendix contains a list of presentations presented during the same period. Following these publications is a list of all Center publications. The Center will attempt to supply the articles to interested and qualified researchers.

### JOURNAL ARTICLES PUBLISHED

Blount, H.P. & Tennyson, R.D. Programmed instruction as a model for instructional design. *NSPI Newsletter,* 1972, *11,* 1.

Boutwell, R.C. & Tennyson, R.D. Instructional objectives: Different by design. *NSPI Journal,* 1972, *10*(7), 7-14.

Tennyson, R.D. A review of experimental methodology in instructional task sequencing. *AV Communication Review,* 1972, *20*(2), 147-159.

Tennyson, R.D., Woolley, R.R., & Merrill, M.D. Exemplar and nonexemplar variables which produce correct concept classification behavior and specified classification errors. *Journal of Educational Psychology,* 1972, *63,* 144-152.

Woolley, F.R. & Tennyson, R.D. Conceptual model of classification behavior. *Educational Technology,* 1972, *12*(4), 37-39.

### JOURNAL ARTICLES ACCEPTED (IN PRESS)

Merrill, M.D. & Tennyson, R.D. Attribute prompting variables and learning classroom concepts. *Journal of Educational Psychology,* 1973, in press.

Merrill, M.D. & Tennyson, R.D. Concept acquisition and specific errors as a function of the relationship between positive and negative instances. *American Educational Research Journal,* 1973, in press.

Tennyson, R.D. An audio-tutorial approach to individualizing college geology instruction. *Improving Human Performance,* 1973, in press.

Tennyson, R.D. Effect of negative instances in concept acquisition using a verbal learning task. *Journal of Educational Psychology,* 1973, in press.

Tennyson, R.D. & Boutwell, R.C. Methodology for the sequencing of instances in classroom concept teaching. *Educational Technology,* 1973, in press.

Tennyson, R.D. & Boutwell, R C. Methodology for defining instance difficulty in concept teaching. *Educational Technology,* 1973, in press.

Tennyson, R.D. & Boutwell, R.C. Pretask versus within-task anxiety measures in predicting performance on a concept acquisition task. *Journal of Educational Psychology,* 1973, in press.

**JOURNAL ARTICLES SUBMITTED**

Boutwell, R.C. & Tennyson, R.D. Anxiety interaction with task difficulty levels, memory support, and estimated task competency in a concept identification task. Submitted *Journal of Experimental Psychology.*

Boutwell, R.C. & Tennyson, R.D. Effect of task sequence and memory support on Indian college students. Submitted *Journal of Educational Psychology.*

Boutwell, R.C. & Tennyson, R.D. Memory monitoring as a function of anxiety level and task difficulty in concept acquisition. Submitted *AERJ.*

James, T. & Brown, B. The effects of prose organization and individual differences on free recall. Submitted *Journal of Educational Psychology.*

Kieffer, L.F. & Tennyson, R.D. The psychomotor domain: Interactive behavior. Submitted *Psychological Review.*

Kieffer, L.F. & Tennyson, R.D. Stressed and nonstressed knowledge of results on state anxiety and heart rate using a psychomotor task. Submitted *Journal of Experimental Psychology.*

Tennyson, R.D. Adaptive instructional model for concept acquisition. Submitted *AV Communication Review.*

Tennyson, R.D. & Boutwell, R.C. Multivariate effect of aptitude and anxiety with performance on task sequence in concept acquisition. Submitted *Journal of Applied Psychology.*

Worthen, B.R. & Tennyson, R.D. Competencies needed in the conduct of quality educational research and evaluation: Implications for training. Submitted *Educational Researcher.*

## PRESENTATIONS

Hansen, D.N. Computer innovations for school librarianship. Florida State University and the Florida Department of Education, Tallahassee, Fla.

Hansen, D.N. & Tennyson, R.D. Presenter, Advanced instructional system. AAAS Annual Meeting. Washington, D.C.

Taylor, S., Hansen, D.N., & Brown, B. A comparison of two public school computer-assisted instruction projects. AERA, Chicago, Ill.

Tennyson, R.D. Chairman, symposium, Alternative computer systems in instruction. American Association for the Advancement of Science, Annual Meeting. Washington, D.C.

Tennyson, R.D. Chairman, symposium, Interrelationship of domains of instructional strategies. 80th Annual APA Convention, Honolulu, Hawaii.

Tennyson, R.D. Instructional paradigms for concept teaching. Presentation to the College of Education, Georgia State University.

Tennyson, R.D. Presenter, Instructional model for concept acquisition. Symposium, Paradigms in concept acquisition. AERA Annual Conference, Chicago, Ill.

Tennyson, R.D. Presenter, Representation of knowledge in written instruction for nonresidential students. Symposium, The application of measurement theory and instructional psychology to nonresidential higher education. AERA Annual Conference, Chicago, Ill.

Worthen, B.R. & Tennyson, R.D. Presenter, Competencies needed in the conduct of quality educational research and evaluation: Implications for training. Symposium, The systematic design of educational research training. 80th Annual APA Convention, Honolulu, Hawaii.

## TECHNICAL REPORTS

The following technical reports were published at the Computer-Assisted Instruction Center at the Florida State University. The Center will attempt to supply upon request the reports to all interested and qualified researchers.

1. Majer, K. *A study of computer-assisted multimedia instruction augmented by recitation sessions,* 1969.

2. Hansen, D. & Majer, K. *Educational applications of instructional computer systems,* 1969.

3. Hansen, D., Dick, W., & Lippert, H. *Research and implementation of collegiate instruction of physics via computer-assisted instruction,* 1969.

4. Hedl, J. *A systematic investigation of three facets of programmed instruction: Tutorial assistance of study, explanation of incorrect answers, and the spacing of high difficulty frames,* 1969.

5. Love, W. *Individual versus paired learning of an abstract algebra presented by computer-assisted instruction,* 1969.

6. O'Neil, H. *Effects of stress on state anxiety and performance in computer-assisted learning,* 1969.

7. Spielberger, C. *The effects of anxiety on computer-assisted learning,* 1969.

8. Hobson, E. *Empirical development of a computer-managed instruction system for the Florida State University model for the preparation of elementary school teachers,* 1969.

9. Hansen, D., O'Neil, H., Brown, B., King, A., & Rivers, L. *Annual progress report,* 1970.

11. Hagerty, N. *Development and implementation of a computer-managed instruction system in graduate training,* 1970.

12. Gallagher, P. *An investigation of instructional treatments and learner characteristics in a computer-managed instruction course,* 1970.

13. Scanland, W. *An investigation of the relative effectiveness of two methods of instruction, including computer-assisted instruction, as techniques for changing the parental attitudes of Negro adults,* 1970.

14. Spielberger, C., O'Neil, H., & Hansen, D. *Anxiety, drive theory, and computer-assisted learning,* 1970.

15. Lipe, J. *The development and implementation of a model for the design of individualized instruction at the university level,* 1970.

16. King, A. *An application of simulation techniques to an innovative teacher training program,* 1970.

17. Harvey, W. *A study of the cognitive and affective outcomes of a collegiate science learning game,* 1970.

18. Gay, L. *Temporal position of reviews and its effect on the retention of mathematical rules,* 1971.

19. Lawler, M. *An investigation of selected instructional strategies in an undergraduate computer-managed instruction course,* 1971.

20. Hansen, D. *Information processing models for reading skill acquisition,* 1971.

21. Hedl, J. *An evaluation of a computer-based intelligence test,* 1971.

22. Dunn, T. *The effects of various review paradigms on performance in an individualized computer-managed undergraduate course,* 1971.

23. Leherissey, B. *The effects of stimulating state epistemic curiosity on state anxiety and performance in a complex computer-assisted learning task,* 1971.

24. Rayner, G. *An empirical study of a methodology for the revision of systematically designed educational materials,* 1972.

25. Durall, E. *A feasibility study: Remediation by computer within a computer-managed instruction course in junior high school mathematics,* 1972.

26. Motley, D. *An on-line computer-managed introduction to indexing: An individualized multimedia instructional package compared to the traditional method, nine hours of teacher-group contact,* 1972.

27. Rivers, L. *Development and assessment of an adaptive strategy utilizing regression analysis techniques for the presentation of instruction via computer,* 1972.

**TECHNICAL MEMOS**

The following technical memos were published at the Computer-Assisted Instruction Center at the Florida State University. The Center will attempt to supply upon request the memos to all interested and qualified researchers.

1. Dick, W. *Implementation of CAI at Florida State University,* 1969.

2. Hansen, D. *Current issues in CAI,* 1969.

3. Hansen, D. *Computer applications in school psychology,* 1969.

4. Ehlers, W. *CAI in social work,* 1969.

5. Dick, W. & Latta, R. *Comparative effects of ability and presentation mode in computer-assisted instruction and programmed instruction,* 1969.

6. Hansen, D., Dick, W., & Lippert, H. *Institute in computer-related multimedia instruction for administrators and faculty in junior colleges and universities,* 1969.

7. Hansen, D., Wright, B., & Hogshead, G. *A guide to running a study in the CAI Center,* 1969.

8. Hansen, D. & Dick, W. *The data world of CAI,* 1969.

9. Dick, W. *An overview of CAI for adult educators,* 1969.

10. Hansen, D. & Harvey, W. *Impact of CAI on classroom teachers,* 1969.

11. Hansen, D. *Development processes in CAI problems, techniques, and implications,* 1969.

12. Gay, L. *An investigation into the differential effectiveness for males and females of three CAI treatments on delayed retention of mathematical concepts,* 1969.

13. Hansen, D., Wright, B., & Johnson, B. *Existing CAI curriculum materials at the FSU-CAI Center,* 1970.

14. Lee, R. *Information structure in military history: An application of computer-assisted instruction,* 1970.

15. Hansen, D. *The role of computers in education during the '70's,* 1970.

16. Adair, C., Hansen, D., Rayner, G., & Agarwal, A. *The behavior of teachers involved in two simulated inquiry environments: A social simulation game and a CAI-based information retrieval system,* 1970.

17. Hansen, D. *Current research development in computer-assisted instruction,* 1970.

18. Sheldon, J. *Computer-assisted instruction in engineering dynamics,* 1970.

19. Bruce, D. & Papay, J. *The primacy effect of single-trial free recall,* 1970.

20. Leherissey, B., O'Neil, H., & Hansen, D. *Effects of memory support on state anxiety and performance in computer-assisted learning,* 1970.

21. Hansen, D., Brown, B., Lippert, H., & O'Neil, H. *Institute in computer-related multimedia instruction for administrators and faculty in junior colleges and universities,* 1970.

22. Jahoda, G. & Foos, F. *The development of an on-line searched coordinate index for use in teaching and research,* 1970.

23. Kromhout, O., Hansen, D., & Schwarz, G. *Conference on computers in undergraduate science education: A computer-assisted and managed course in physical sciences,* 1970.

24. Geisert, P. *A comparison of the effects of information mapped learning materials and traditional materials on the learning of concepts via the printed page and computer cathode ray tube,* 1970.

25. Graham, D., Schwarz, G., & Hansen, D. *Multimedia simulation of laboratory experiments in a basic physics lesson on magnetism,* 1970.

27. Merrill, P. *Task analysis--An information processing approach,* 1971.

28. Dunn, T., Lushene, R., & O'Neil, H. *The complete automation of the Minnesota Multiphasic Personality Inventory and a study of its response latencies,* 1970.

30. Hansen, D., Hedl, J., & O'Neil, H. *Review of automated testing,* 1971.

31. Thomas, D. *Two applications of simulation in the educational environment,* 1971.

32. Dick, W. & Gallagher, P. *Systems concepts and computer-managed instruction: An implementation and validation study,* 1971.

33. Rappaport, E. *The effects of trait and dogmatism on state anxiety during computer-assisted learning,* 1971.

34. Leherissey, B. *The development of a measure of state epistemic curiosity,* 1971.

35. Hansen, D. & Johnson, B. *Measurement techniques for individualized instruction in CAI,* 1971.

36. Brown, B., Hannum, W., & Dick, W. *An investigation of the effects of two types of instructional terminals in computer-managed instruction,* 1971.

37. Brown, B. & O'Neil, H. *Computer terminal selection: Some instructional and psychological implications,* 1971.

38. Hansen, D. & Johnson, B. *CAI myths that need to be destroyed and CAI myths that we ought to create,* 1971.

39. Summerlin, L. *A feasibility study of tutorial type computer-assisted instruction in selected topics in high school chemistry,* 1971.

40. Jahoda, G. & Foos, F. *The use of an on-line searched and printed coordinate index in teaching,* 1971.

41. Leherissey, B., O'Neil, H., & Hansen, D. *Effect of anxiety, response mode, and subject matter familiarity on achievement in computer-assisted learning,* 1971.

42. Leherissey, B., O'Neil, H., Heinrich, D., & Hansen, D. *Effect of anxiety, response mode, subject matter familiarity, and learning time on achievement in computer-assisted learning,* 1971.

43. Tobias, S. *A history of an individualized instructional program of varying familiarity to college students,* 1972.

44. Tobias, S. *Review of the response mode issue,* 1972.

45. Merrill, P. & Duchastel, P. *The effects of behavioral objectives on learning: A review of empirical studies,* 1972.

46. Towle, N. & Merrill, P. *Effects of anxiety type and item difficulty sequencing on mathematics aptitude test performance,* 1972.

47. Merrill, P. & Towle, N. *The effects of the availability of objectives on performance in a computer-managed graduate course,* 1972.

48. Lushene, R., O'Neil, H., & Dunn, T. *Equivalent validity of a completely computerized MMPI,* 1972.

49. Tobias, S. & Hedl, J. *Test anxiety: Situationally specific or general,* 1972.

50. Hansen, D. & Brown, B. *Attitude and personality scale for CAI research,* 1972.

51. Tobias, S. *A rationale for computer art,* 1972.

52. Tobias, S. *Distraction, response mode, anxiety, and achievement from CAI,* 1972.

53. Johnson, B. *Systematic approaches to the development of instruction for adult basic education,* 1972.

54. Hansen, D., Manning, P., & Johnson, B. *A systems approach to learning simulations,* 1972.

55. Adair, C., Hansen, D., Johnson, B., & Steve, M. *A replication of a study of social science simulations,* 1972.

56. Tobias, S., Hedl, J., & Towle, N. *Latency and test anxiety,* 1972.

57. Tobias, S. & Duchastel, P. *Behavioral objectives, sequence, and aptitude treatment interactions in CAI,* 1972.

58. Tobias, S. & Leftwich, M. *Study habits and test anxiety,* 1972.

59. Merrill, P., Steve, M., Kalisch, S., & Towle, N. *The interactive effects of the availability of objectives and/or rules on computer-based learning: A replication,* 1972.

60. Dunn, T. & Hansen, D. *Learning by graphics: Translating verbal information into graphic network formats,* 1972.

61. Merrill, P. & Towle, N. *Interaction of abilities and anxiety with availability of objectives and/or test items on computer-based task performance,* 1972.

62. Brown, B. & Luyben, P. *Wakulla final report,* 1972.

63. Hansen, D. *Computer innovations for school librarianship,* 1972.

64. Kromhout, O. *Effect of computer tutorial review lessons on exam performance in introductory college physics,* 1972.

65. Taylor, S., Hansen, D., & Brown, B. *A comparison of two public school CAI projects,* 1972.

66. Duchastel, P. *Incidental and relevant learning with instructional objectives,* 1972.

67. James, T. & Brown, B. *The effects of prose organization and individual differences on free recall,* 1972.

**SYSTEMS MEMOS**

The following systems memos were published at the Computer-Assisted Instruction Center at the Florida State University. The Center will attempt to supply upon request the memos to all interested and qualified researchers.

1. O'Neil, H., Hansen, D., Freed, B., Wester, E., Hogshead, G., & Robinson, W. *Documentation for the edit and data preparation programs,* 1970.

2. O'Neil, H., Papay, S., & Hansen, D. *Supplementary documentation of Coursewriter II functions,* 1970.

3. Lippert, H., Harris, E., Thomas, D., & McMurchie, T. *Manual of APL/1500 functions,* 1970.

4. Lippert, H. & Harris, D. *APL: An alternative to the multilanguage environment for education,* 1970.

5. Freed, B., O'Neil, H., Lauffer, L., & Lushene, R. *Teleprocessing: A DEC 680 interfaced to an IBM 1500,* 1970.

6. Hansen, D., Papay, J., O'Neil, H., & Danner, D. *Human-computer interactions involved in analysis of CAI data,* 1970.

8. McMurchie, T., Krueger, S., & Lippert, H. *A programming language/1500,* 1970.

9. Kribs, D., Wright, B., & Reynolds, E. *FOCAL manual for CAI coding on the TSS/8 system,* 1970.

10. McMurchie, T. & Thomas, D. *APL/1500 file access subroutine package,* 1971.

11. McMurchie, T. & Thomas, D. *Manual of APL/1500 functions: Systems functions,* 1971.

12. Thomas, D., Merrill, P., & Hansen, D. *STATSIM: Exercises in statistics,* 1971.

13. McMurchie, T. & Krueger, S. *A programming language/1500 (APL/1500) operator's guide,* 1971.

14. McMurchie, T. & Thomas, D. *Manual of APL/1500 functions: Systems functions,* 1971.

15. McMurchie, T. *Operation of offline programs for generating and maintaining the APL/1500 system,* 1972.

## APPENDIX B

### DEMONSTRATIONS 1972

The CAI Center provided computer demonstrations for both university and nonuniversity personnel. Following is a list of the requestors and their affiliations along with the number of persons attending the demonstrations.

**Florida State University**

| | |
|---|---|
| Dr. E.A. Frechette, Language Education | 6 |
| Dr. C. Adair, Social Sciences | 20 |
| Dr. H.W. Stoker, Educational Research | 30 |
| Calvino Guimaraes, AIF Program | 1 |
| Dr. Ed Harris, Educational Administration | 3 |
| Ms. Ruge, Educational Administration | 1 |
| Dr. W. Dick, Board of Regents | 10 |
| Dr. W.R. Tschinkel, Biological Science | 2 |
| Jack Taylor, Music | 8 |
| Dr. R.G. Stakenas, DIRS | 10 |
| Dr. B. Brown, CCSI | 2 |
| Dr. Ed Harris, Educational Administration | 1 |
| Barbara Johnson, CAI | 1 |
| Bob Sanchez, Education | 12 |
| J. Newman, Educational Administration | 10 |
| D. Sprague, Educational Research | 4 |
| Joyce Holt, Educational Administration | 5 |
| Dr. Riedel, Education | 2 |
| Yvonne Moffat, Education | 1 |
| Walton Cobb, Educational Administration | 19 |
| Calvin Bolin, University School | 36 |
| Dr. D. Hansen, CAI | 38 |
| George Dawson, Science Education | 20 |
| Dr. Ernest Burkman, Science Education | 1 |
| Cal Marshall, Physical Education | 20 |
| Dr. W.M. Rideout, Educational Research | 2 |
| Dr. L.V. Rasmussen, Educational Administration | 10 |
| Steve Taylor, Mathematics Education | 7 |
| Dr. G. Belden, Dept of Education | 13 |
| Physical Education Department | 19 |

**Other Demonstrations**

| | |
|---|---|
| Sister Marilyn, Blessed Sacrament School | 29 |
| Sherrill Sarvis, Astoria Park Elementary School | 35 |
| Dr. Hawkins, North Florida Junior College | 6 |

Other visitors to the FSU-CAI Center, but not included in the preceding list were:

Dr. Joseph Federico, Lowry AFB, Denver, Colo.
M.M. Bryant, Computer Sciences, Hartford, Mass.
Dr. Hug, U. of Auburn, Alabama
Tom O'Sullivan, Raytheon Co., Norwood, Mass.
K.B. Taylor, Computer Sciences, Falls Church, W. Va.
Robert J. Taft, Science Course Improvement, UES, NSF, Washington, D.C.
Richard T. Murrary, Systems Development Corp., Santa Monica, Calif.
John W. Dale, Jr. Comprehensive Criminal Justice Manpower Project
Carla M. Stennett, Comprehensive Criminal Justice Manpower Project
Laurie C. Wilson, Boulder Valley Public Schools, Colo.
Charles Sisson, Boulder Valley Public Schools, Colo.
Larry A. Pope, Boulder Valley Public Schools, Colo.
Fran Watts, National Science Foundation, Washington, D.C.
Keith R. Kelson, National Science Foundation, Washington, D.C.
Dr. Klaus Eyferth, Technischie Hochschule, Darmstadt, Germany
Jim Baker, U.S. Army Behavior & Systems Reg. Lab, Washington, D.C.
Joseph Zeidner, U.S. Army Behavior & Systems Reg. Lab, Washington, D.C.
Dr. David R. Reinhardnew, F&M Systems, Dallas, Tex.
Francis C. Axtell, F&M Systems, Dallas, Tex.
Mr. Dautzenberg, Computing Center of Tech. Univer., Aachen, Germany
Ray Panko, Stanford University, Stanford, Calif.
Prof. Joe Hyun Kim, Dept. of Public Administration, Seoul, Korea
Pablo Willstater, Instituto Perriario de Formento Education, Peru
L.F. Geldart, Fed. Univ. of Bahia, Salvador, Brazil
William G. Shingler, Jr., Decatur, Georgia
Bob Fisher, Data Design Laboratories, Falls Church, Va.
Muiricio San Maitin, Inst. Nav. Investigeion of Perfecious, Peru
Dr. Marisio, Ministry of Education, Peru
Francis A. Gana, Federal Ministry of Education, Kaduna, Nigeria
Al Adler, Physics Dept., FSU, Tallahassee, Fla.
Dwight Farringer, Physics Dept. Manchester College
Dr. Al Bork, University of California, California
Ms. Sureg Suvarnasorn, Ministry of Education, Bangkok, Thailand
Anit Swangkam, Dept. of Vocational Education, Bangkok, Thailand
Thorgehai Suwatmekin, Bagpra Agricultural College, Cholburi, Thailand
Vira Layraman, Northern Bangkok Eng. School, Bangkok, Thailand
Boworn Muangsuwan, Bangpra Agricultural College, Cholburi, Thailand
Pinet Michaidit, Bangkok, Thailand
Dr. Mohamed L. Bourguerra, Univer. of Tunis
Dr. Daniel Doslef, Dept. of Eduation, Glasgow, Scotland
J.T. Braun, Glasgow, Scotland